

# ***Wisconsin Distributed Generation Initiatives***

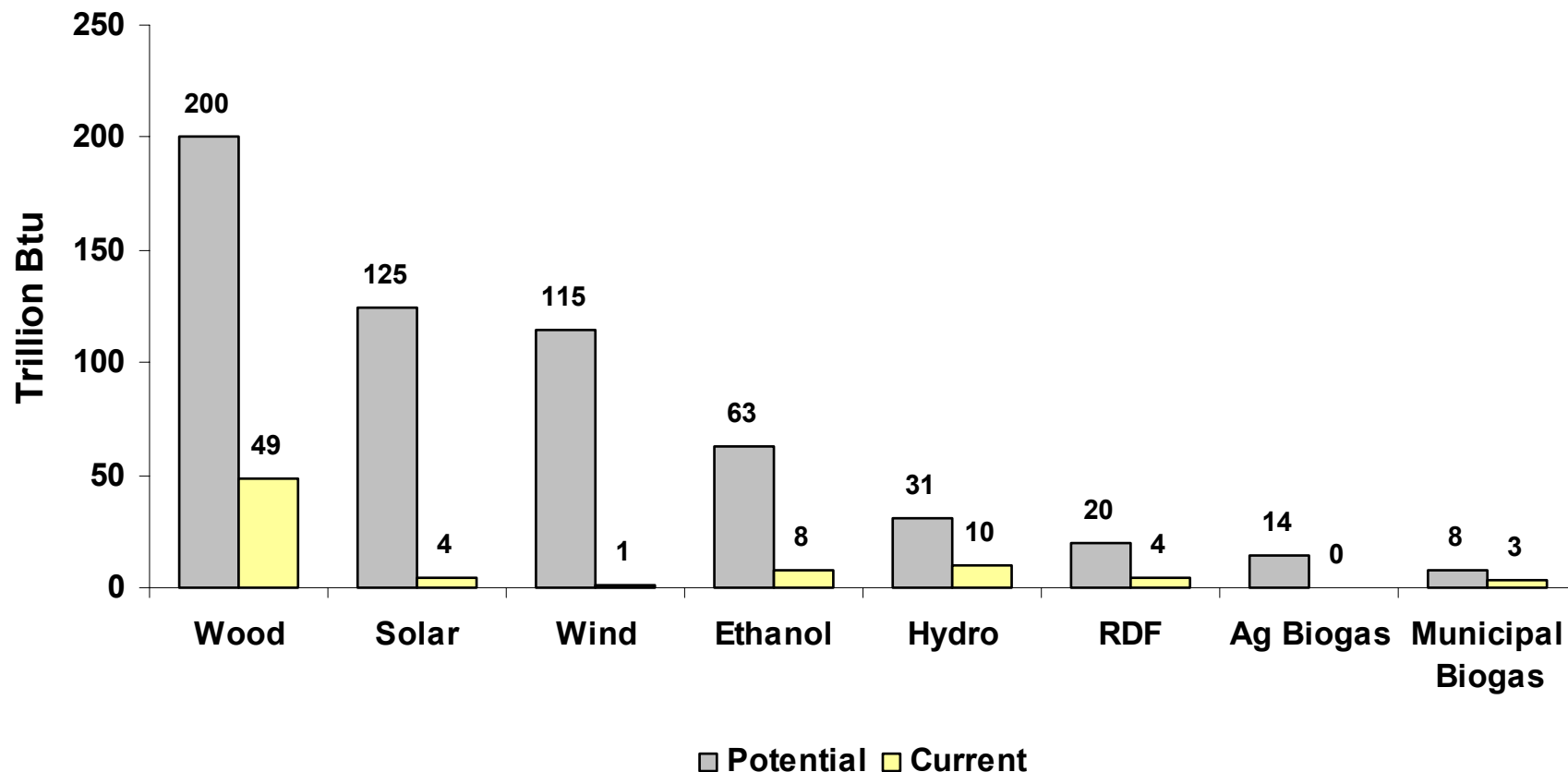
**Larry Krom**

Manager: Business Sector, R&D  
Renewable Energy Program

***2003 Distributed Energy Resources Road Show***



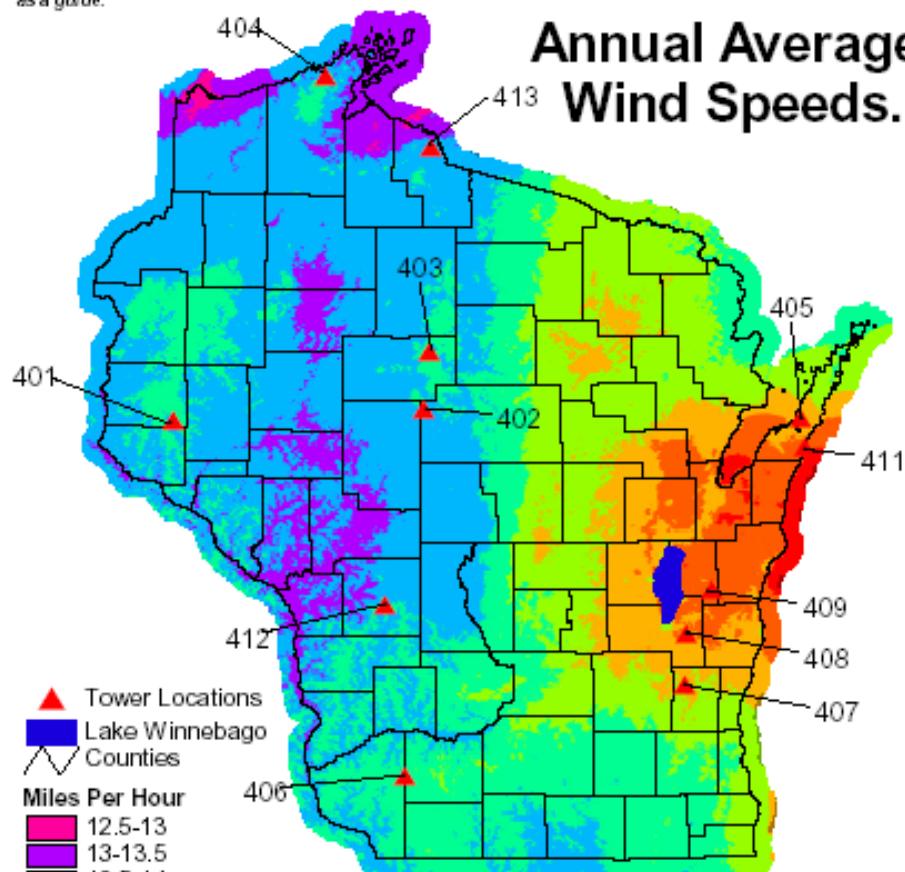
# Wisconsin Renewable Energy Potential and Current Use





# Wind Resource

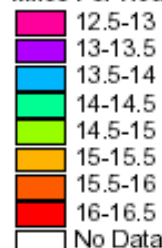
Warning! Field observations are still necessary to help determine if a particular site is suitable for the development of wind farms. This is to be used only as a guide.

## Annual Average Wind Speeds.



▲ Tower Locations  
 Lake Winnebago  
 Counties

Miles Per Hour



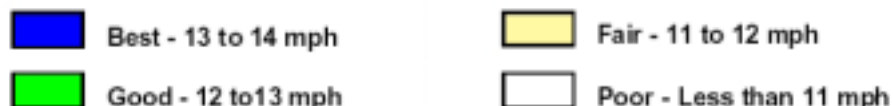
This data set is a 30-meter resolution, which represents estimated annual average wind speeds in meters per second at 60 meters above ground. The calculations were derived using a special modeling software called WindMap. This grid represents 1 year of concurrent data from 12 anemometers placed at strategic places throughout the state.

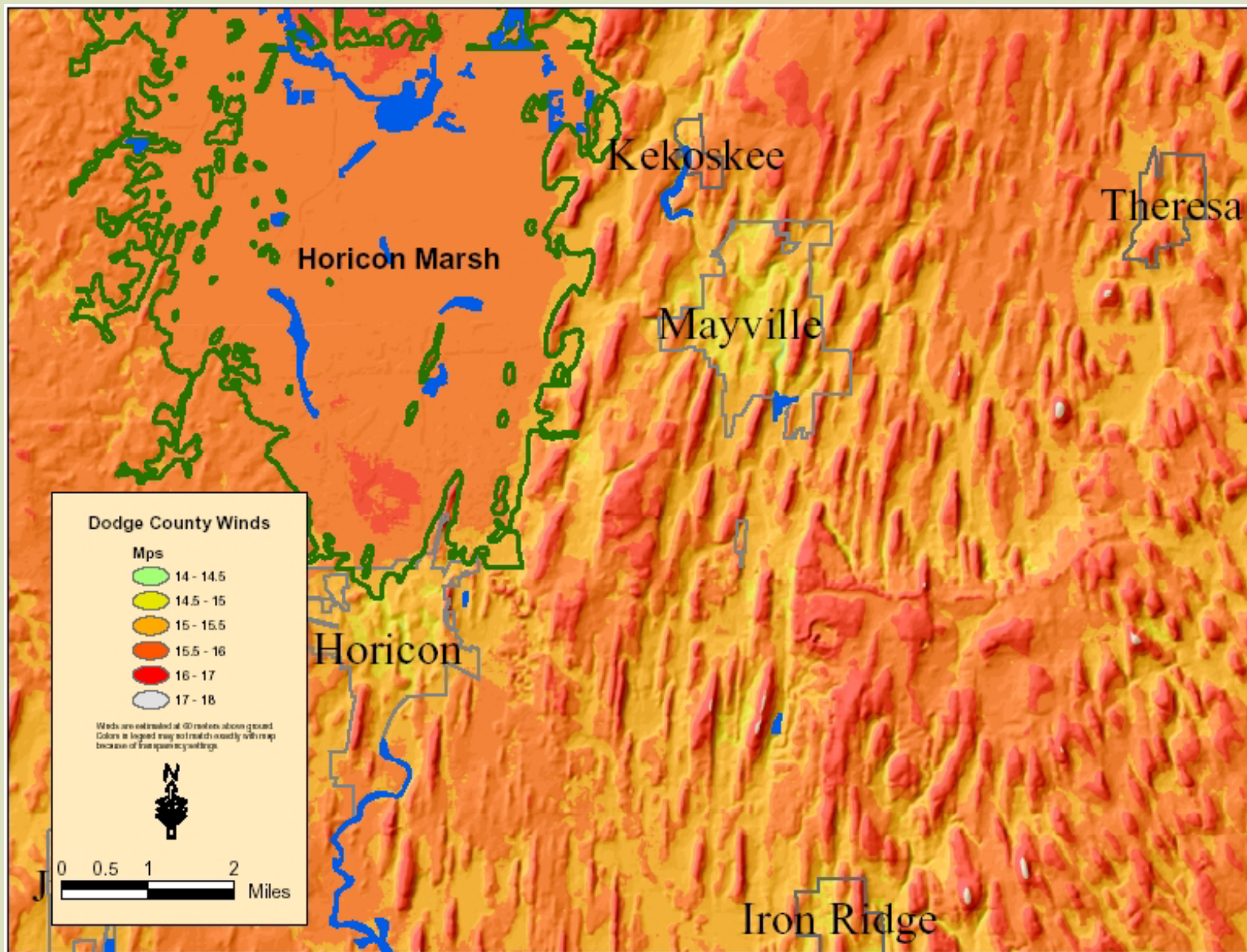
It was developed solely for locating areas which offer the best wind potential for the development of wind farms. The decision to use 60 meters above ground was because most wind turbines measure 60 meters from the base to the hub of the fan.



Map produced by:  
 Wisconsin Department of Administration  
 Wisconsin Energy Division

This map displays areas where annual average wind speeds at some sites (extrapolated to a height of 110 feet) measure:







# ***Small Wind Turbines***



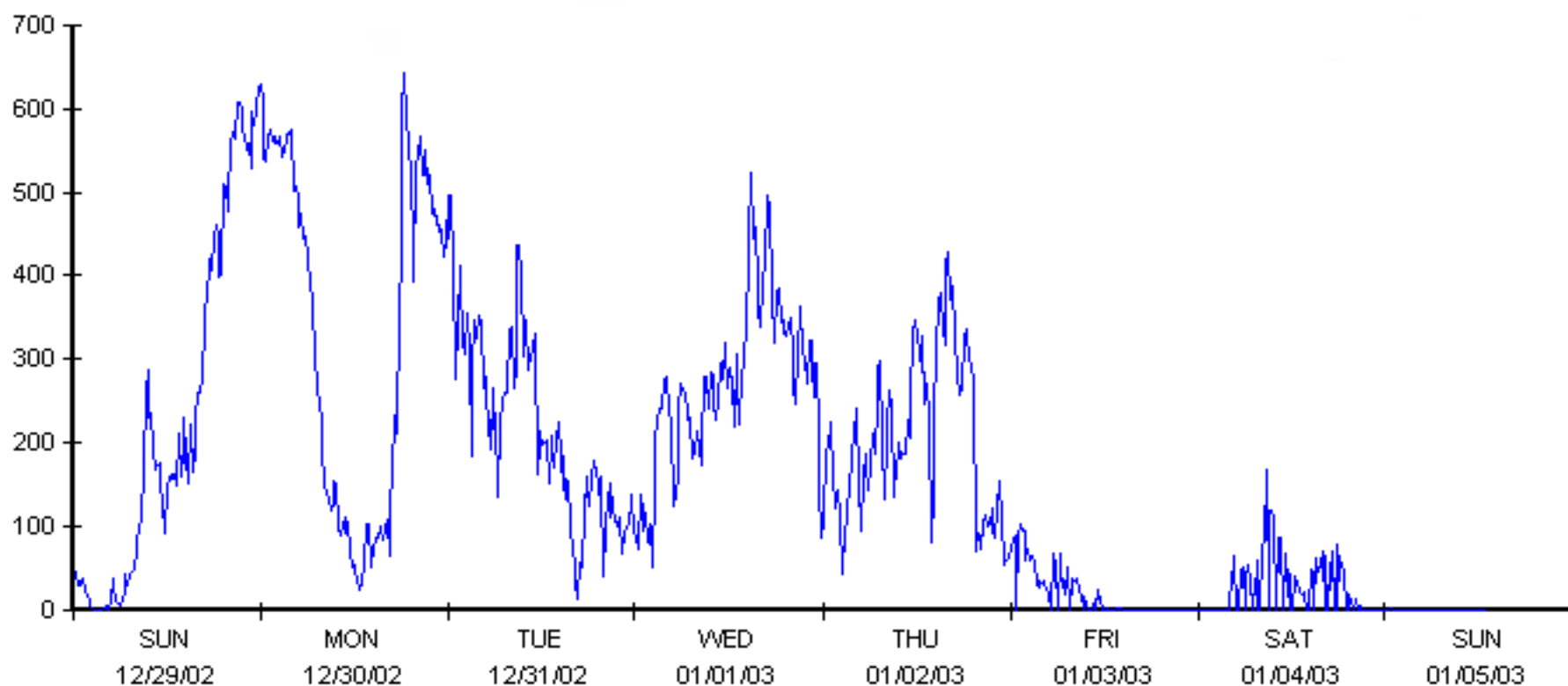
# ***Large Wind Turbines***





<b>Project Location</b>	<b>Owner</b>	<b>Size, MW</b>	<b>Power Purchaser</b>	<b>Turbines</b>
<b>De Pere</b>	<b>4 WI utilities</b>	<b>1.2</b>	<b>4 WI utilities</b>	<b>2, Tacke 600</b>
<b>Rosiere, Kewaunee County</b>	<b>MG&amp;E</b>	<b>11.22</b>	<b>MG&amp;E</b>	<b>17, Vestas V-47-660</b>
<b>Lincoln / Kewaunee County</b>	<b>WPS</b>	<b>9.24</b>	<b>WPS</b>	<b>14, Vestas V-47-660</b>
<b>Byron, Fond du Lac County</b>	<b>WE Energies</b>	<b>1.32</b>	<b>WE Energies</b>	<b>2, Vestas V-47-660</b>
<b>Montfort, Iowa County</b>	<b>FPL</b>	<b>30</b>	<b>WE Energies Alliant Energy</b>	<b>20, GE 65m-1.5</b>



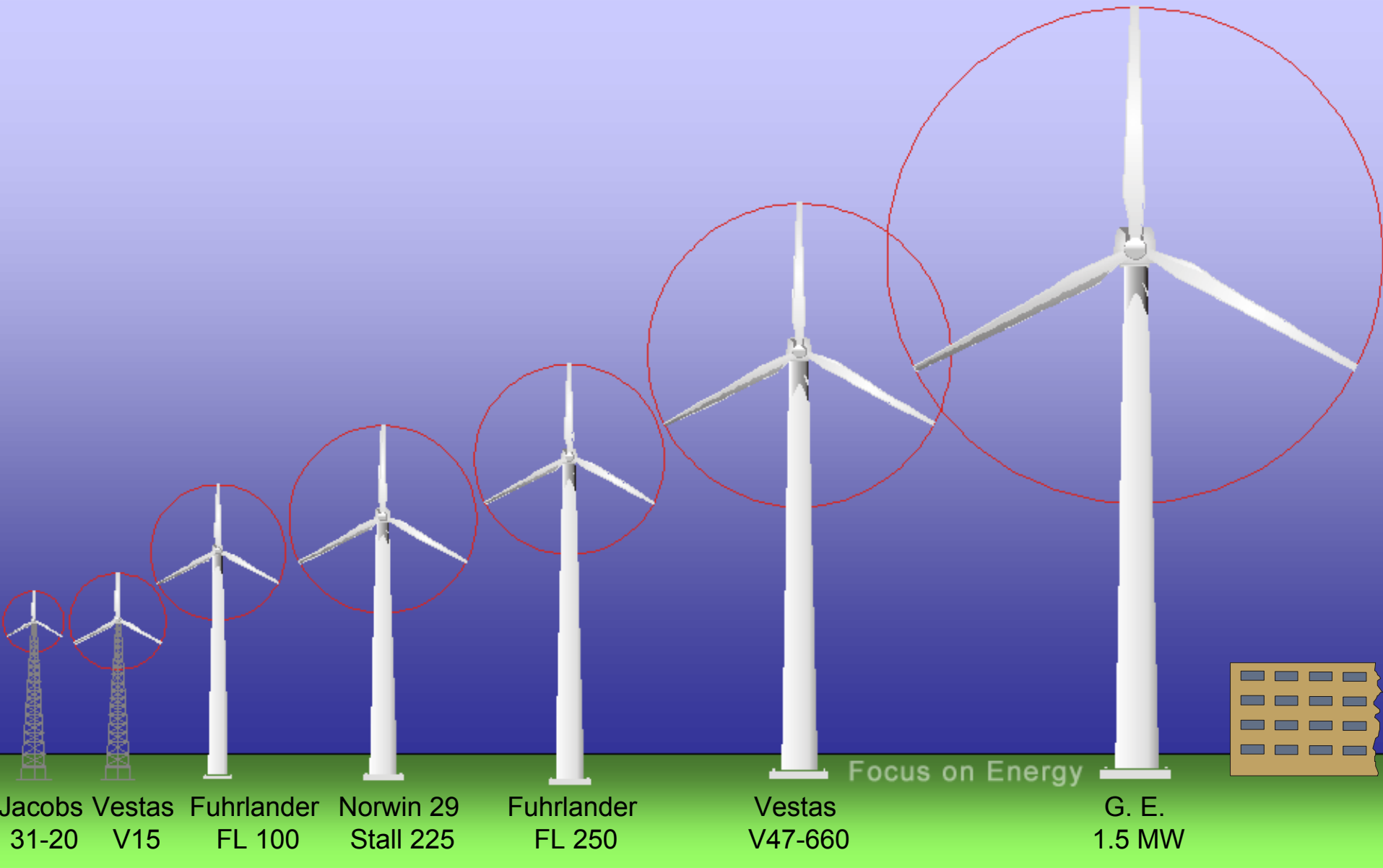


# ***Community Based Wind***



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# Landfill Gas





# Methane from Municipal Wastewater

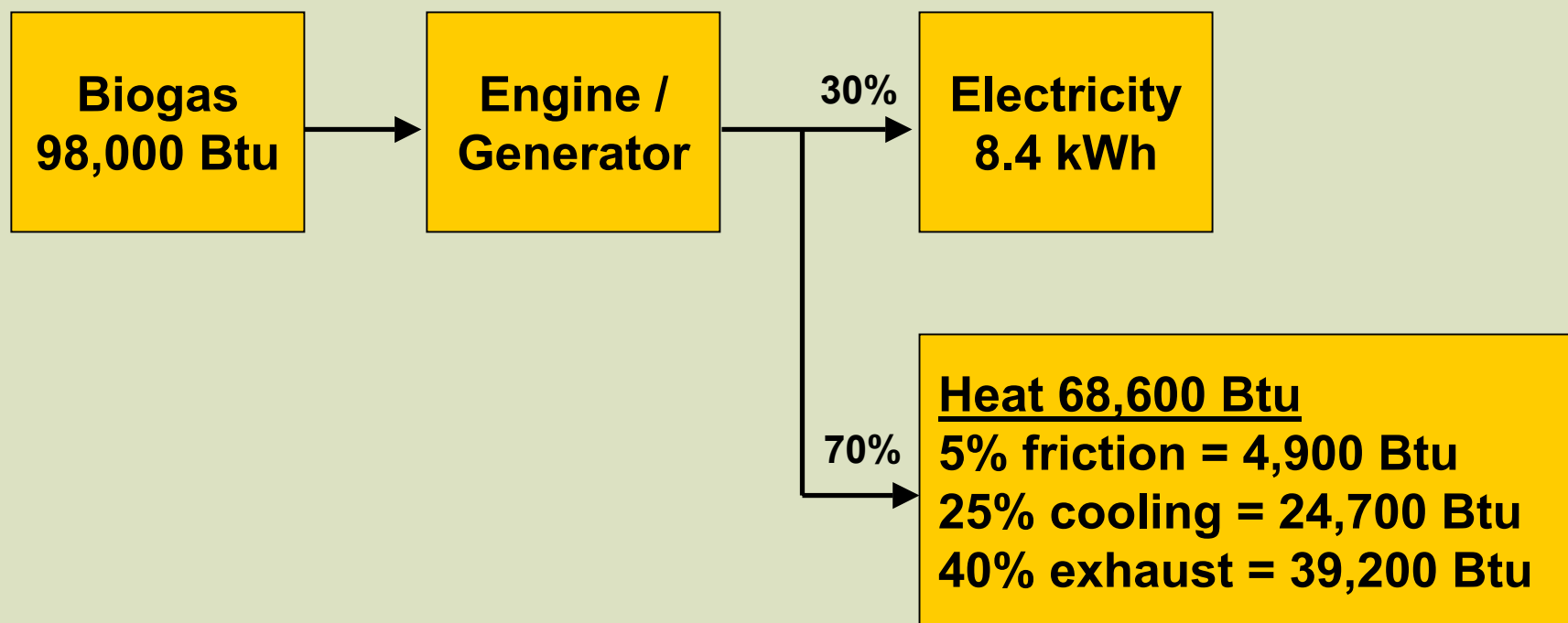


# Manure Digester



# ***Combined Heat and Power is a Goal***

**For example: daily energy production per cow**





# ***Relative Scale of Renewable Generators***

<b>Approx. Cost</b>	<b>Type of Renewable Electric Generator</b>	<b>Homes Powered</b>
\$1,500,000	1.5 MW Wind Turbine	325
\$750,000	660 kW Wind Turbine	145
\$46,000	20 kW Wind Turbine	3.5
\$9,000	1 kW Solar Electric (PV)	0.15
\$550,000	Manure Digester (600 cows)	130
	Landfill-Methane Genset	1,560
	Wood Biomass Power Plant	19,390



# Implementation Issues for Interconnection



## ***What is Interconnection?***

**The physical connection of a distributed generation facility to the distribution system so that parallel operation can occur.**





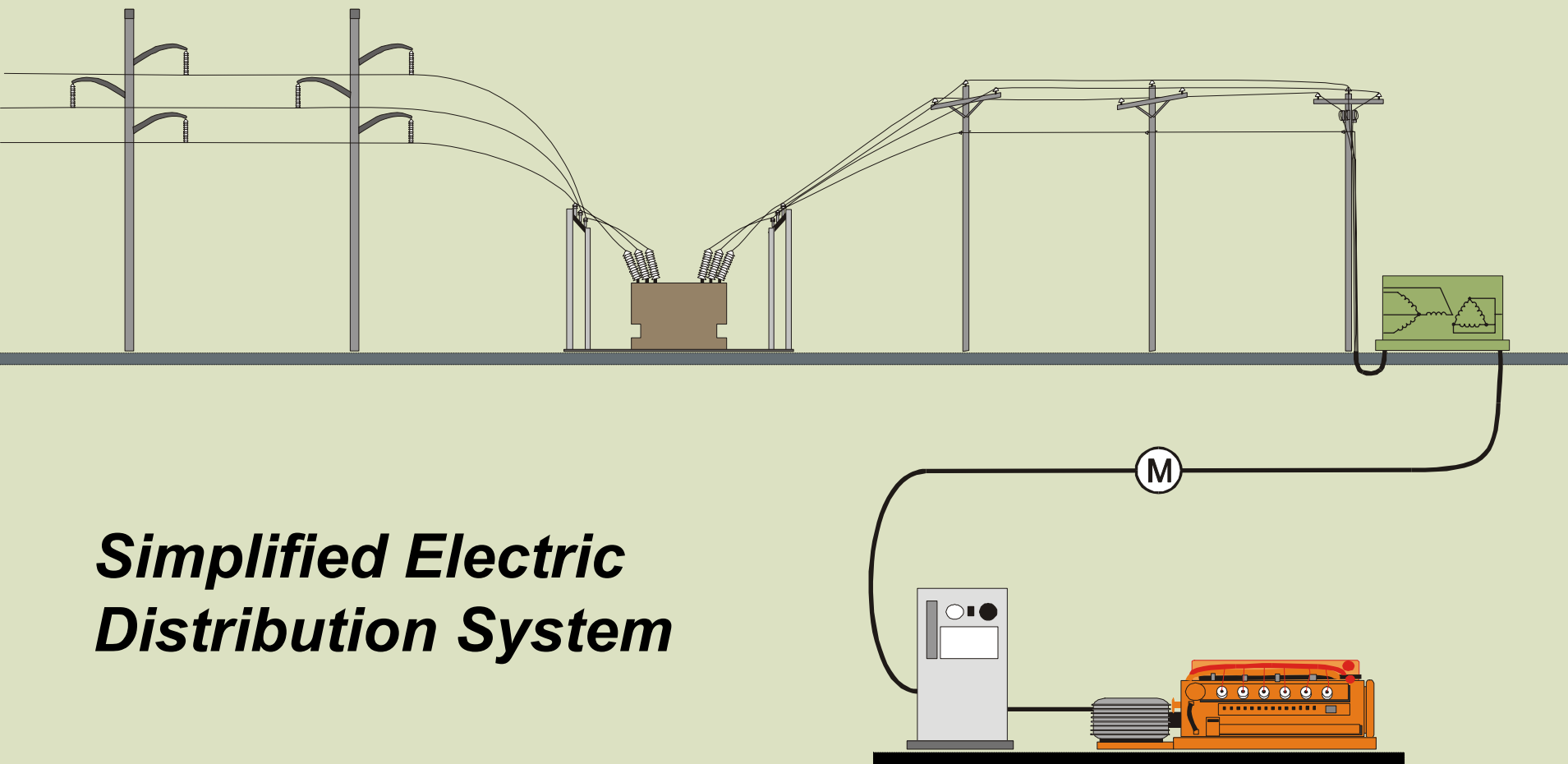








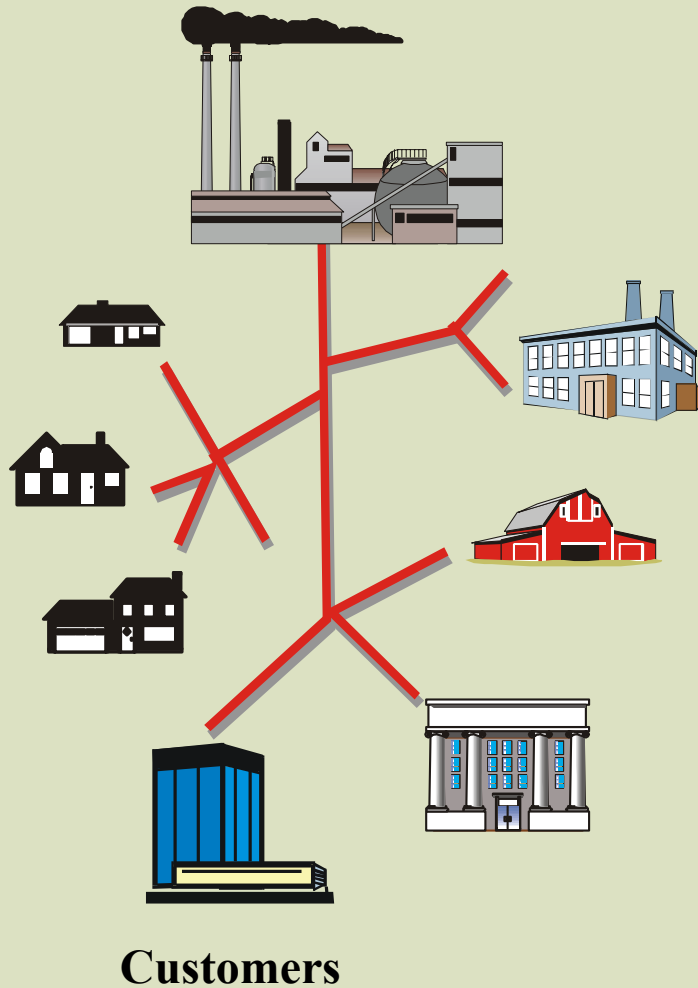




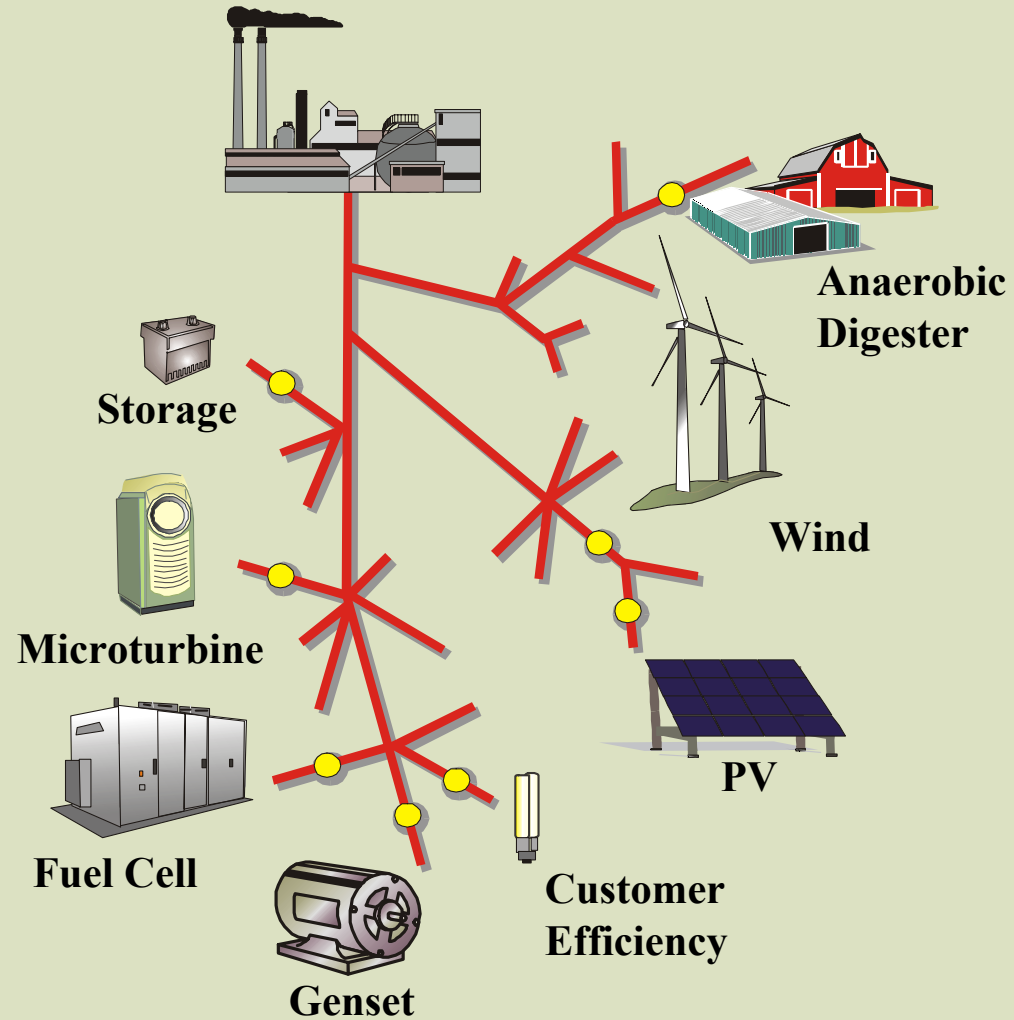
## ***Simplified Electric Distribution System***



## Central Generation

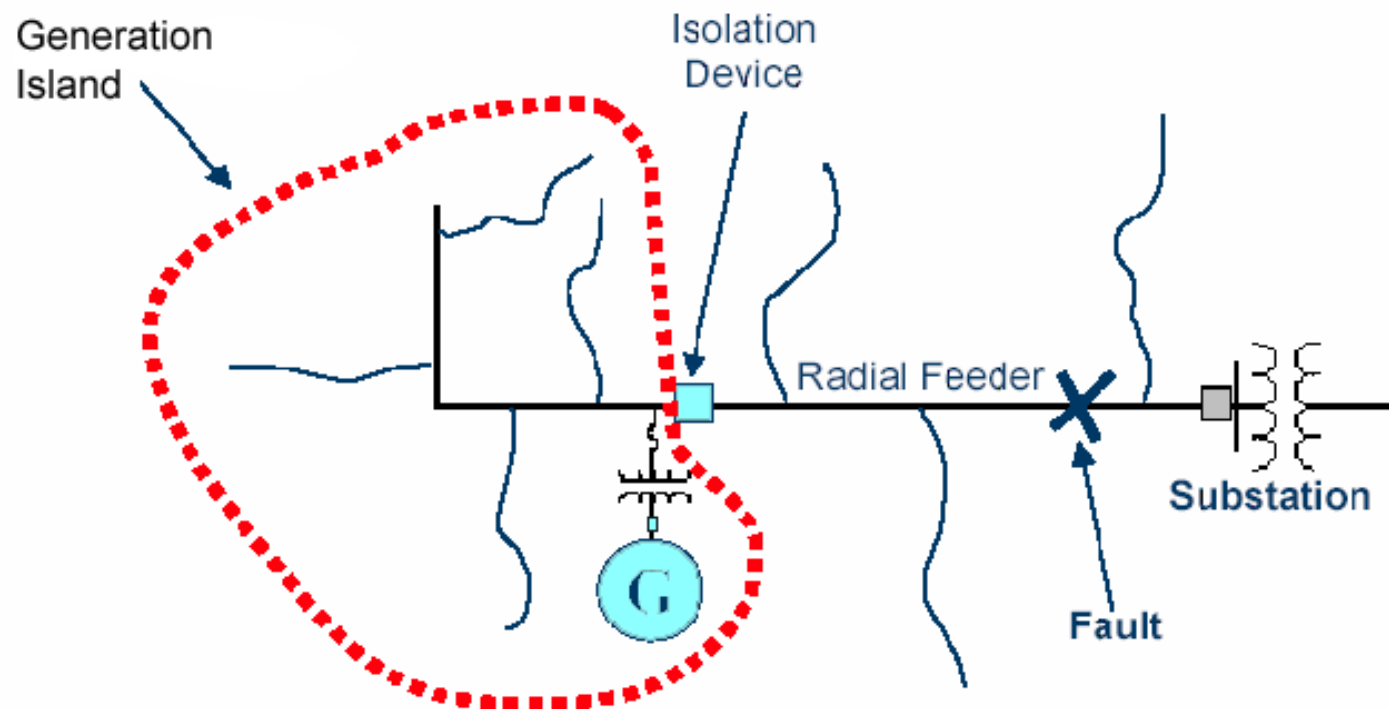


## Distributed Generation



# ***Why Interconnection Practices Are Important***

- **Power Quality**
- **Safety**     e.g., islanding prevention
- **Coordination with Distribution System**





**New Wisconsin  
interconnection rules will  
apply to distribution  
system interconnections  
operating at 50 kV or less.**



*Interconnection design requirements will follow a national standard:*

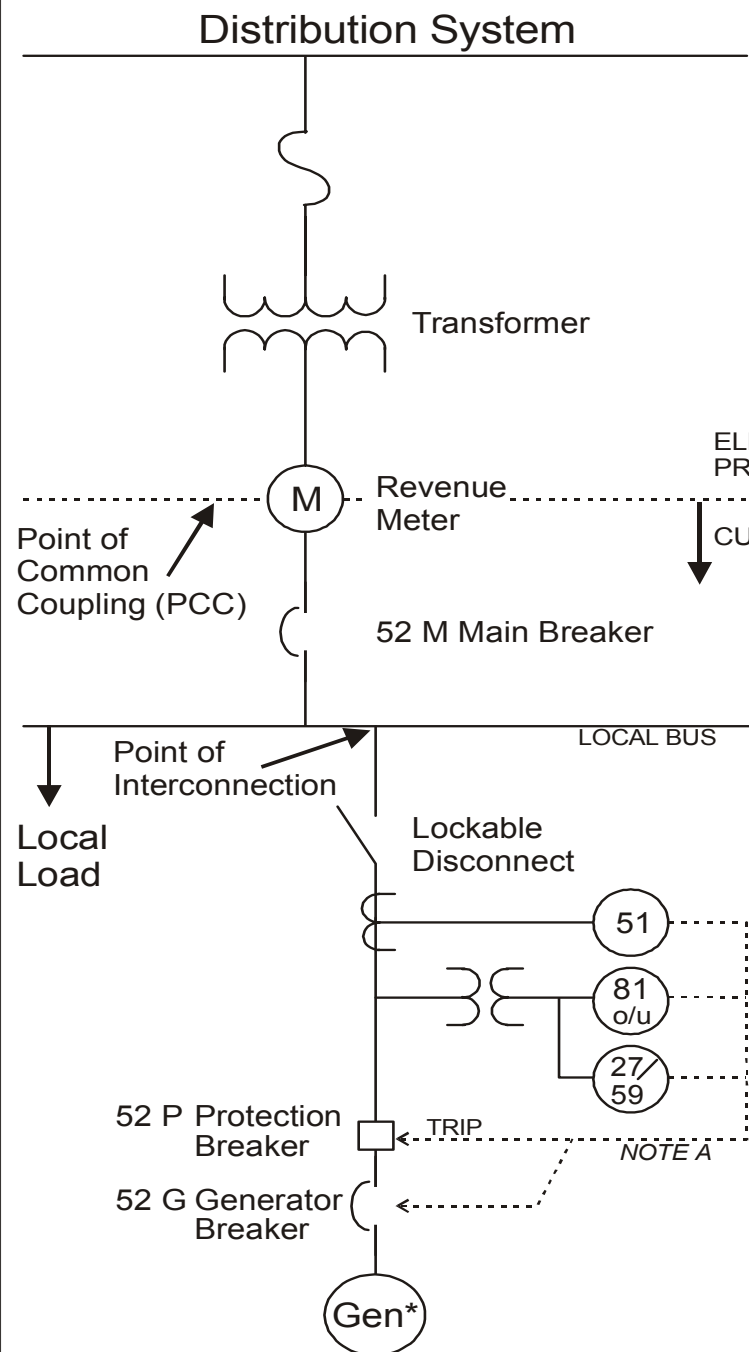
## **IEEE P1547**

**Standard for Distributed Resources  
Interconnected with Electric Power Systems**

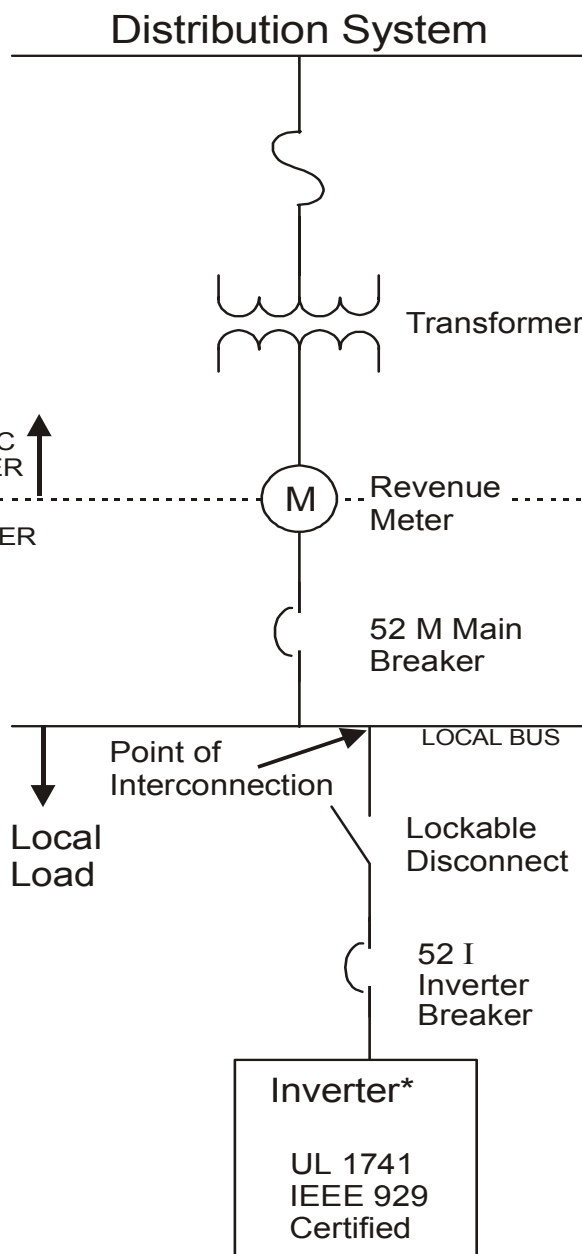
# ***Technical Requirements***

- **Interconnection disconnect switch**
- **Proper grounding practices**
- **Operating limits: islanding & power quality**
- **Minimum protection requirements**
- **Telemetry** (where required)
- **One-line schematic diagram**
- **Site plan**

(Generator Interconnection Example)



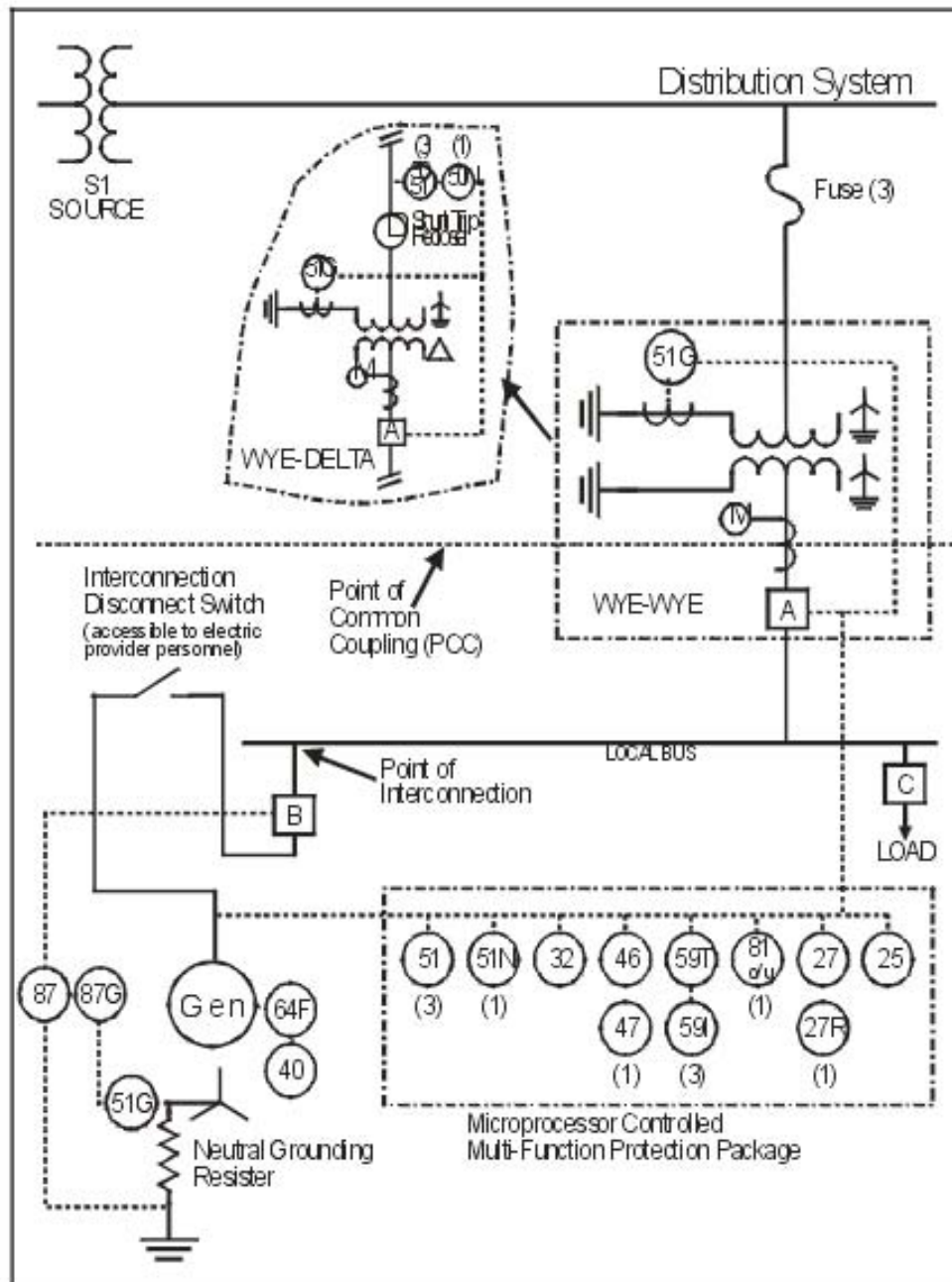
(Inverter Interconnection Example)



# Example One-line Schematic Diagram

## Category 1 (20 kW or less)

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*The power is within you.*



## Example One-line Schematic Diagram

**Categories 2 - 4  
(more than  
20 kW)**



# ***Focus on Energy Program Goals Wisconsin Act 9 (1999)***

- **Increase customer use of renewable energy**
- **Rural economic development**
- **Electric system reliability**
- **Research technology transfers of renewable energy**
- **Educate consumers & businesses about renewable energy**
- **Provide environmental protection**

# ***Renewable Program Objectives***

- **Build confidence in the market**
- **Demonstrate technology innovations**
- **Reduce costs**
- **Assess resources**
- ***Develop standards***
- ***Promote best practices***
- **Advance favorable policies**

# ***Our objectives are based on overcoming barriers to renewable energy***

- **Market barriers**
- **Tax barriers**
- **Technical barriers**
- **Regulatory barriers**
- **Institutional barriers**

# ***Provide Meaningful Program Support at All Project Stages***

- **Technical information that is manufacturer neutral**
- **Feasibility studies**
- **Incentives**
- **Commissioning**
- **Demonstration**
- **Coordinate linkages between public/private entities**



## **Incentives should not create a false market:**

- **Require buy-in from the customer, 50% or more**
- **Encourage partnering to reduce risk, put effort into business models**
- **Base incentives on results – energy produced, not project cost**
- **Average renewable energy-based incentive from Focus is 25% or less, of large project cost**

# ***Feasibility Study Grants***

## **Eligible Activities**

- **Feasibility studies**
- **Economic assessments**
- **System design**
- **Commissioning**

**Maximum Award: \$20,000**

**Cost Share: 50%**

# ***Business and Marketing Grants***

## **Eligible Activities**

- **Business plans**
- **Market assessments**
- **Marketing campaigns**
- **Business or staff certification**
- **Web page, brochures, etc.**

**Maximum Award: \$20,000**

**Cost Share: 50%**

# ***Photovoltaic Cash-Back Reward***

- **Cash-back reward based on energy produced in a year multiplied by \$2/kWh (for one year):**  
**1 kW system produces about 1,200 kWh/year**
- **Maximum Reward: \$50,000 or 50% of installed cost, whichever is less**

## **Examples:**

- **2 kW system at 14% capacity factor generates about 2,450 kWh/year**  
**Approx. Reward = \$5,200**
- **10 kW system at 14% capacity factor generates 12,260 kWh/year**  
**Approx. Reward = \$24,530**

# ***Biomass/Biogas Cash-Back Reward***

- Bioenergy award based on energy produced in a year:  
 $\text{Award} = 2100 \times (\text{kW} \times \text{CF})^{0.63}$
- Maximum Reward: \$50,000 or 50% of installed cost, whichever is less

## **Examples - engine gensets operated on biogas:**

- 100 kW system at 90% capacity factor generates  
1,482,192 kWh/year                      Approx. Reward = \$35,760
- 375 kW system at 90% capacity factor generates  
2,956,500 kWh/year                      Approx. Reward = \$82,230  
Actual Reward = \$50,000

# ***Small Wind Turbine Cash-Back Reward***

- Wind turbine reward based on the rated capacity of the turbine in kW;     AND
- An estimate of the amount of electricity (in kWh's) that the turbine will produce in an average year.
- Maximum Reward: \$50,000 or 50% of installed cost, whichever is less

## **Examples:**

- Bergey Excel S - 10 kW will produce about 15,800 kWh/year   Reward ( $\$1.15/\text{kWh} \times 15,800 \text{ kWh}$ ) = \$18,170
- Jacobs 31-20 - 20 kW will produce about 31,500 kWh/year  
Reward ( $\$0.50 \times 31,500 \text{ kWh}$ ) = \$15,768



# ***Large Wind Turbine Cash-Back Reward***

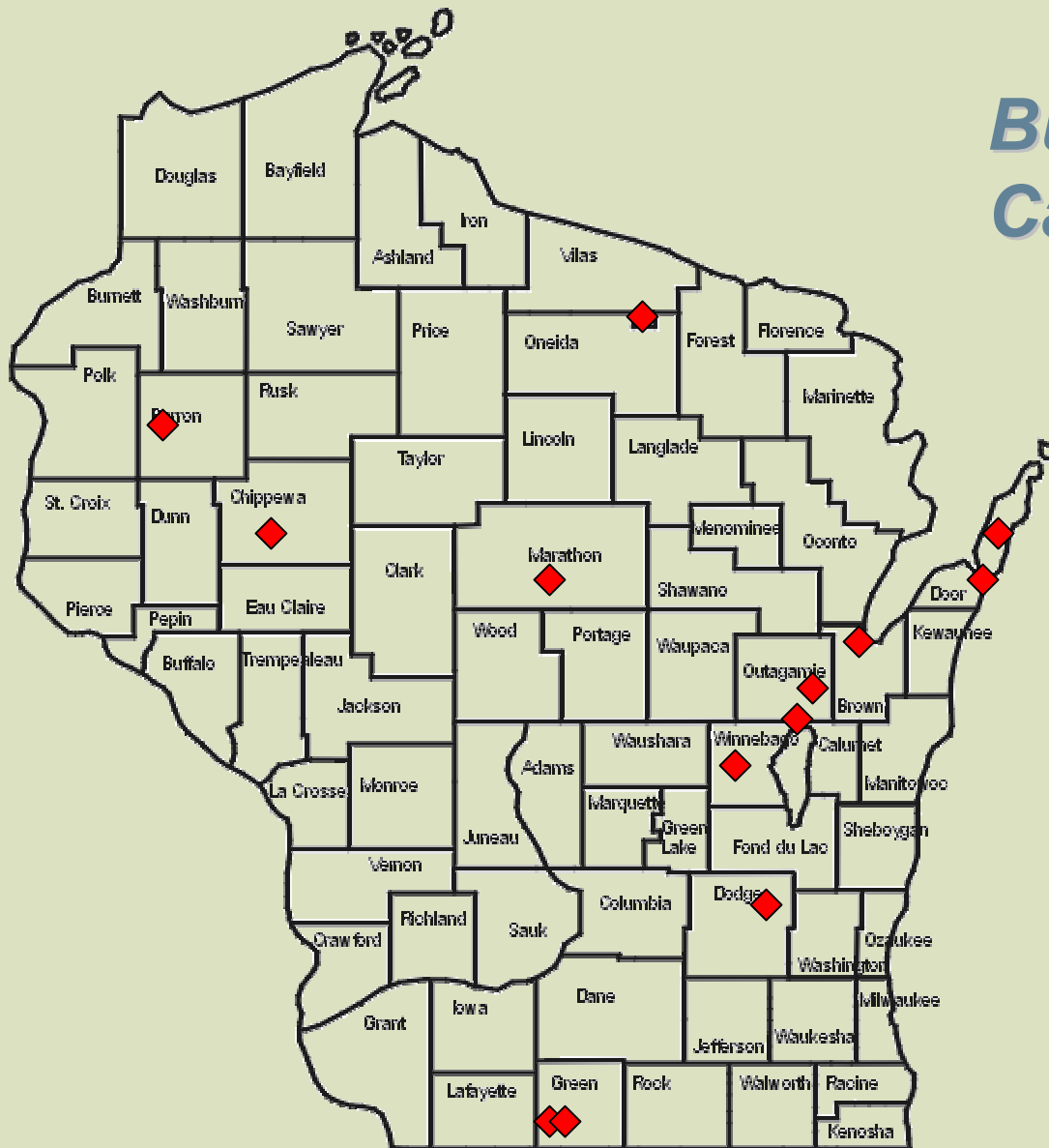
- **Vestas V-15, 65 kW (110 ft tower) → 102,500 kWh/year**  
Reward ( $\$0.35 \times 102,500 \text{ kWh}$ ) = **\$35,875**
- **Fuhrlander 100 kW → 175,000 kWh/year**  
Reward ( $\$0.30 \times 175,000 \text{ kWh}$ ) = \$52,500 → **\$50,000**
- **Fuhrlander 250 kW → 438,000 kWh/year**  
Reward ( $\$0.25 \times 438,000 \text{ kWh}$ ) = \$109,500 → **\$50,000**
- **Vestas V47-660 → 1,387,584 kWh/year**  
Reward ( $\$0.20 \times 1,387,500 \text{ kWh}$ ) = \$277,500 → **\$50,000**
- **Vestas V52-850 → 1,787,000 kWh/year**  
Reward ( $\$0.15 \times 1,787,000 \text{ kWh}$ ) = \$268,050 → **\$50,000**
- **GE 65m-1.5 → 3,154,000 kWh/year**  
Reward ( $\$0.10 \times 3,154,000 \text{ kWh}$ ) = \$315,400 → **\$50,000**

# Results



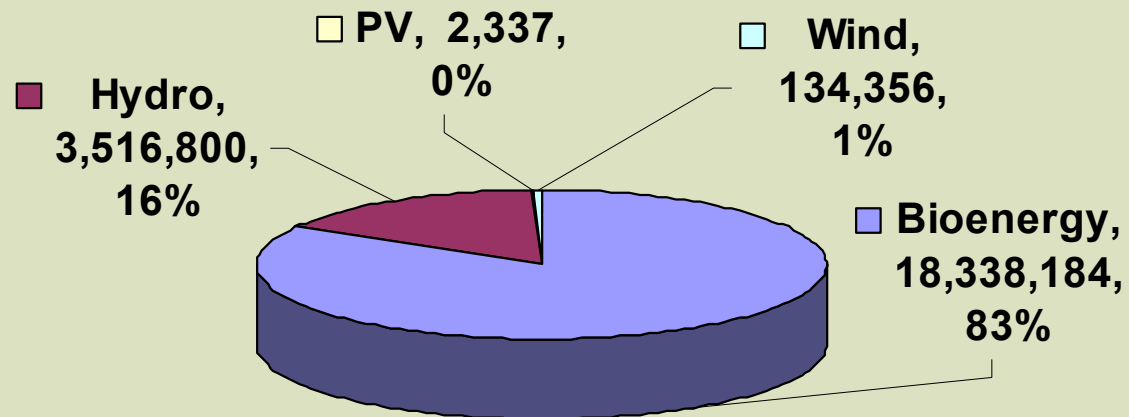
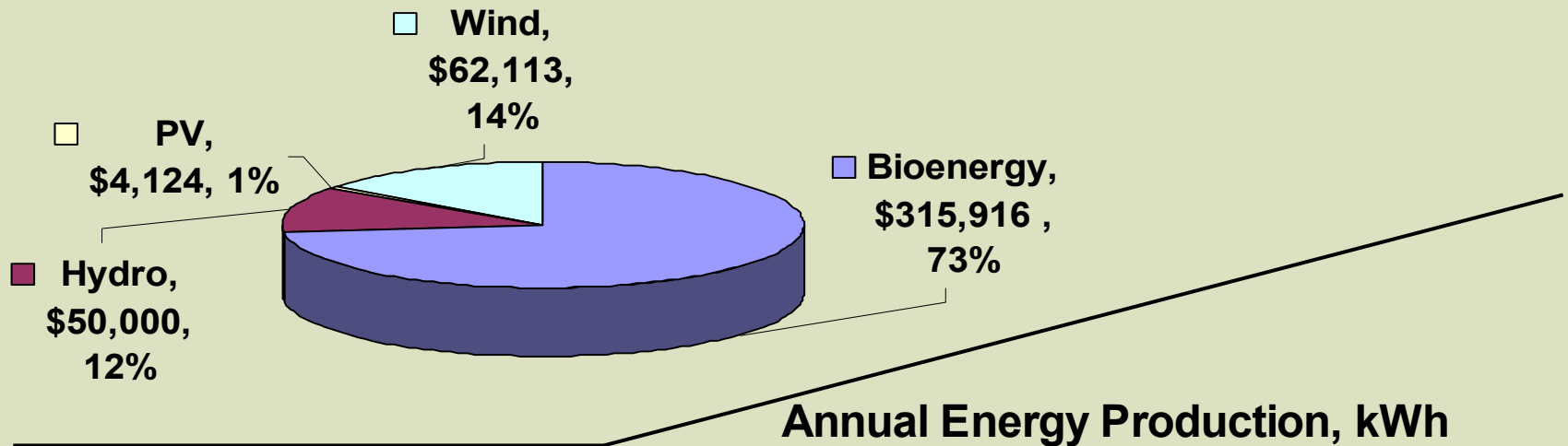
**Milwaukee Recycle Training Center**

# ***Business Sectors Cash Back Rewards***

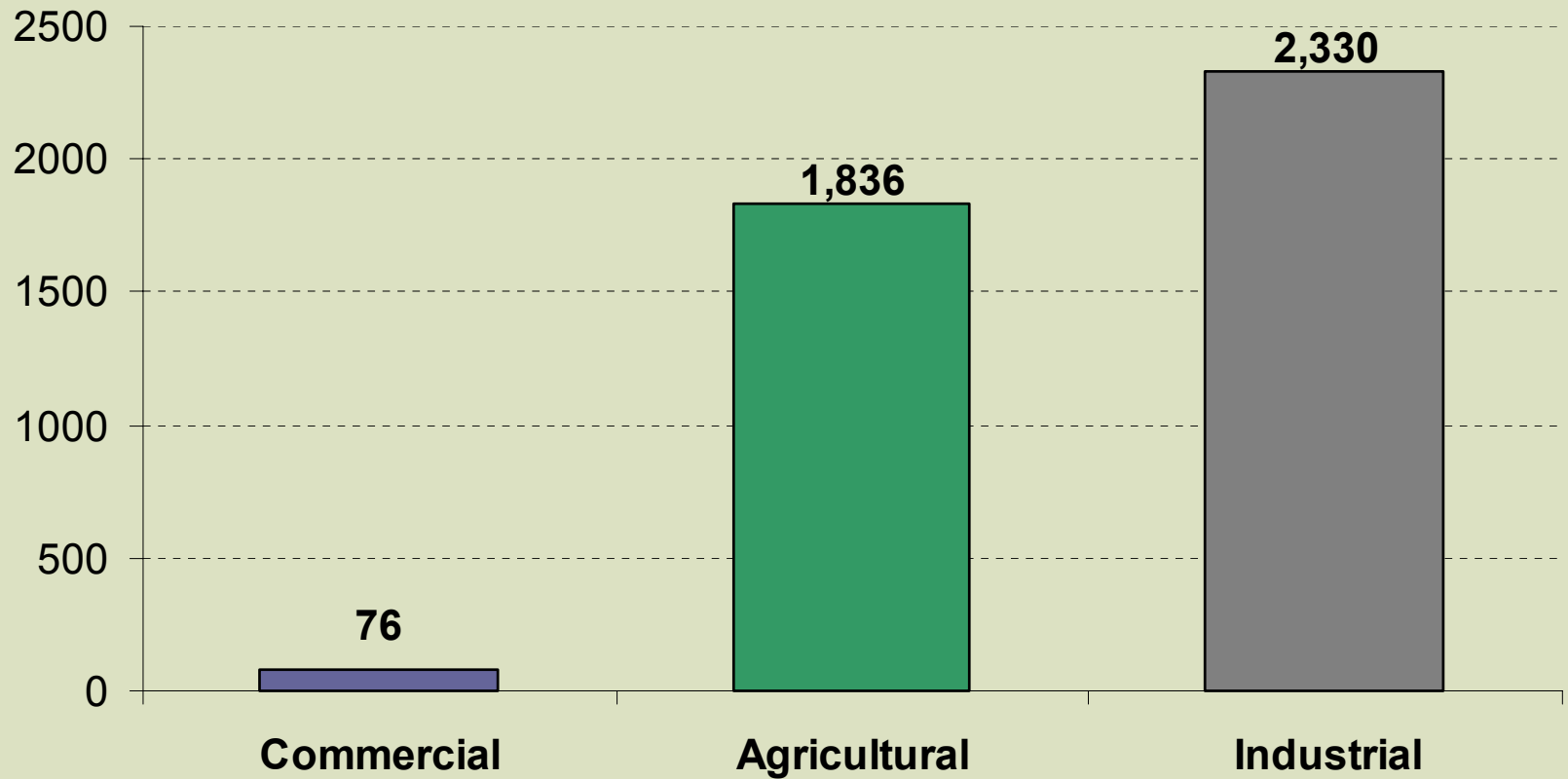


Focus Funds: \$ 432,153  
Projects Cost: \$ 7,385,988  
Dollar Match: 16 to 1

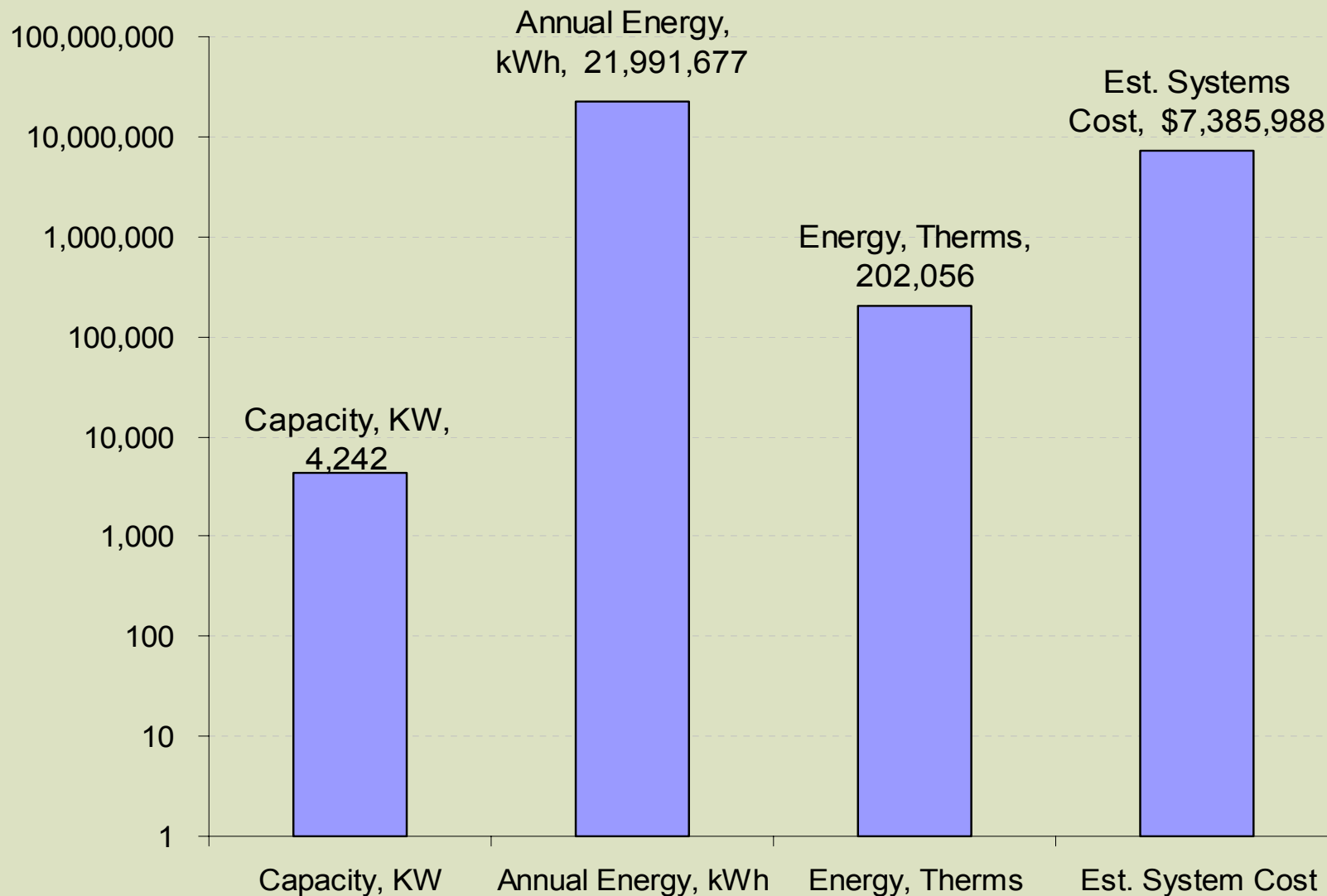
## Cash Back Rewards, By Technology



## Capacity, by Sector in KW



# Cash Back Reward Expenditures \$ 432,153





- ◆ Business/Marketing
- ◆ Demonstration
- ◆ Feasibility
- ◆ R & D

Focus Funds: \$ 852,464  
Projects Cost: \$ 2,493,042

\$ 130,016

Dollar Match 2 to 1

\$ 158,405

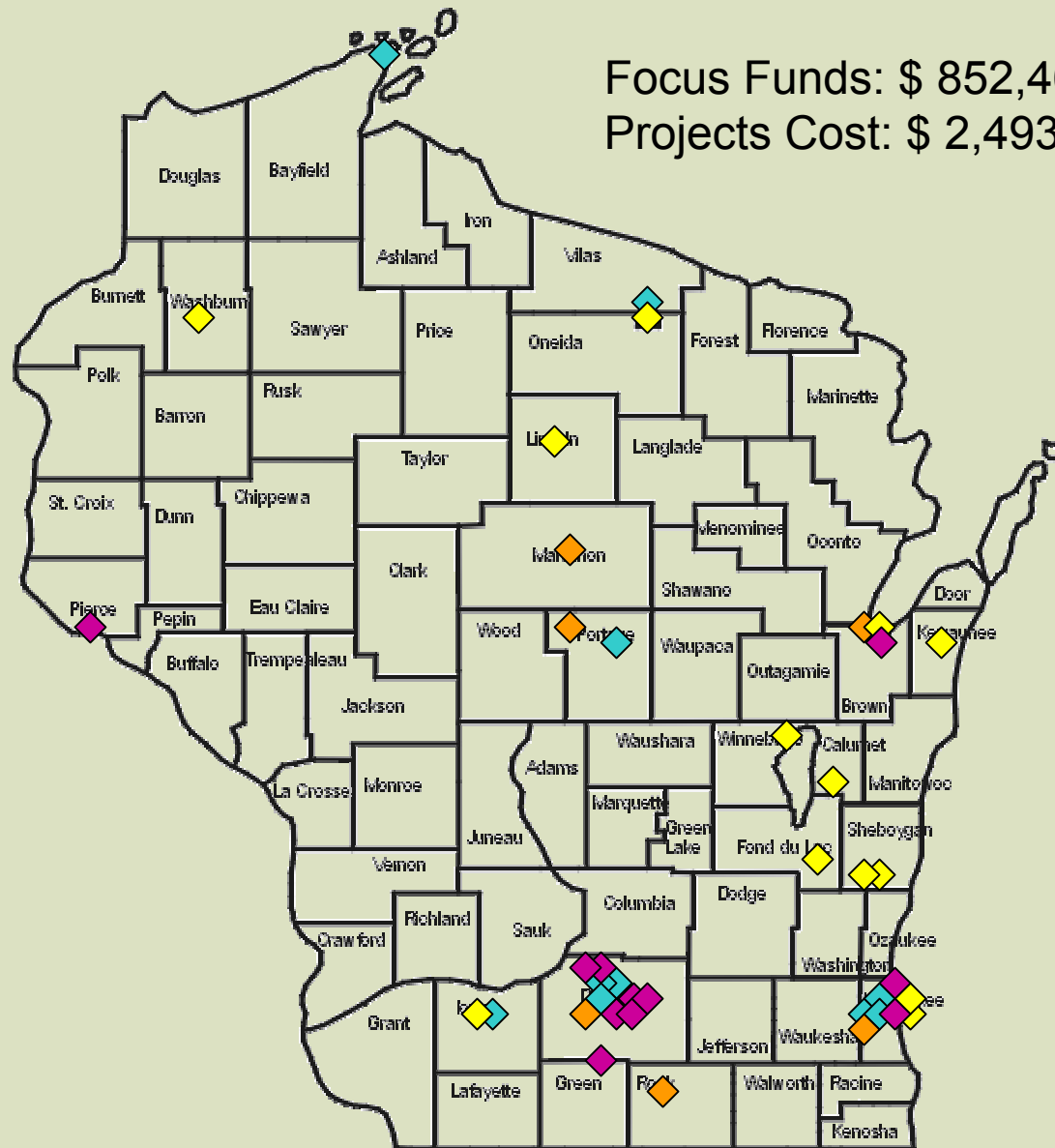
Dollar Match 4 to 1

\$ 158,405

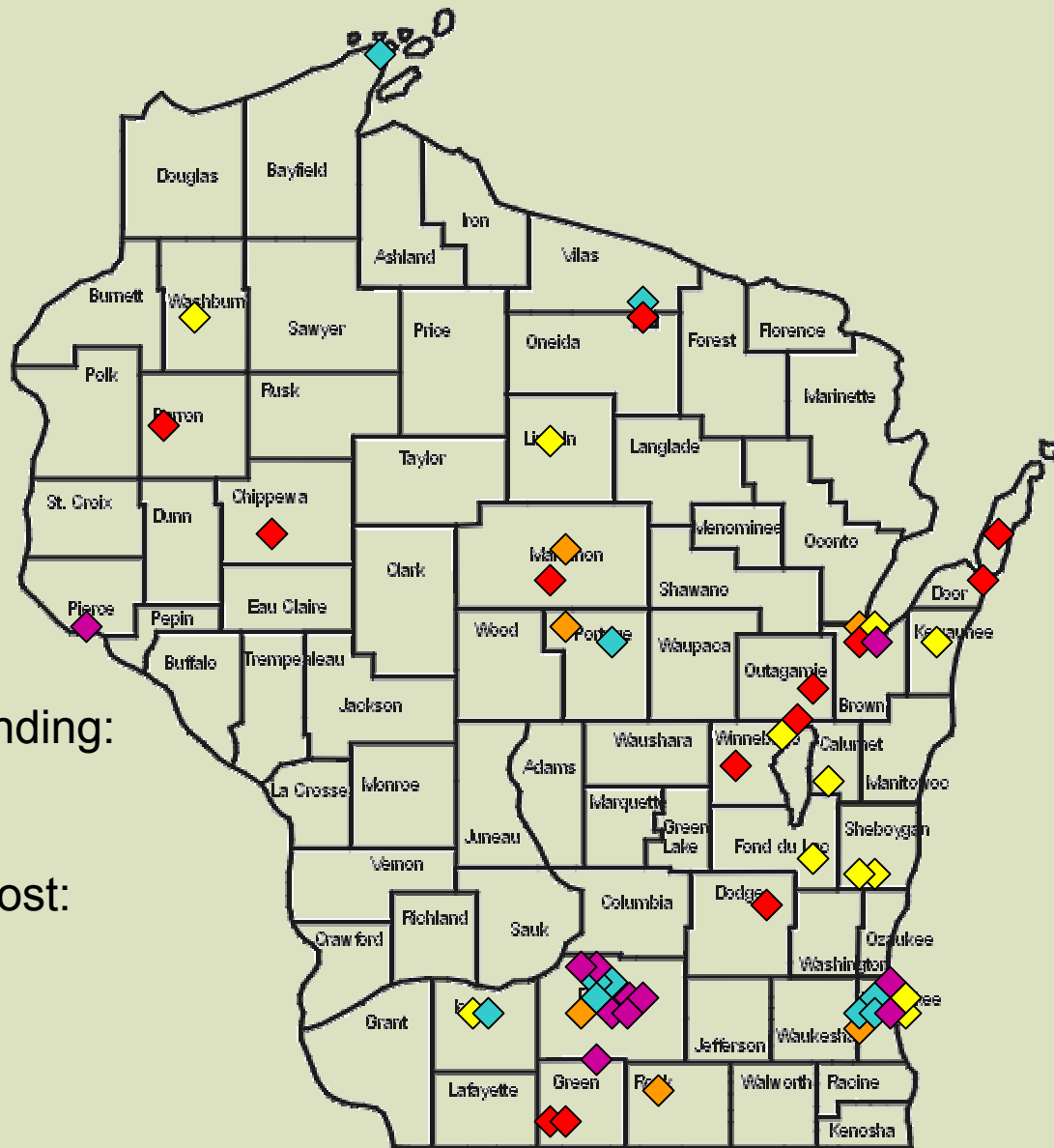
Dollar Match 4 to 1

\$ 399,315

Dollar Match 1 to 1



# Business Sectors Funding Summary



Business Sectors Funding:  
\$ 1,284,617

Projects Estimated Cost:  
\$ 9,879,030

Dollar match 6.7 to 1

# ***Business Sectors Projects Funded***

CashBack Rewards	13
Business/Marketing	12
Demonstration	6
Feasibility	13
R & D	11
<b>Total</b>	<hr/> <b>55</b>

# Technical College Demonstration Project Funding

◆ Technical College  
Demonstrations

Focus Funds: \$210,000

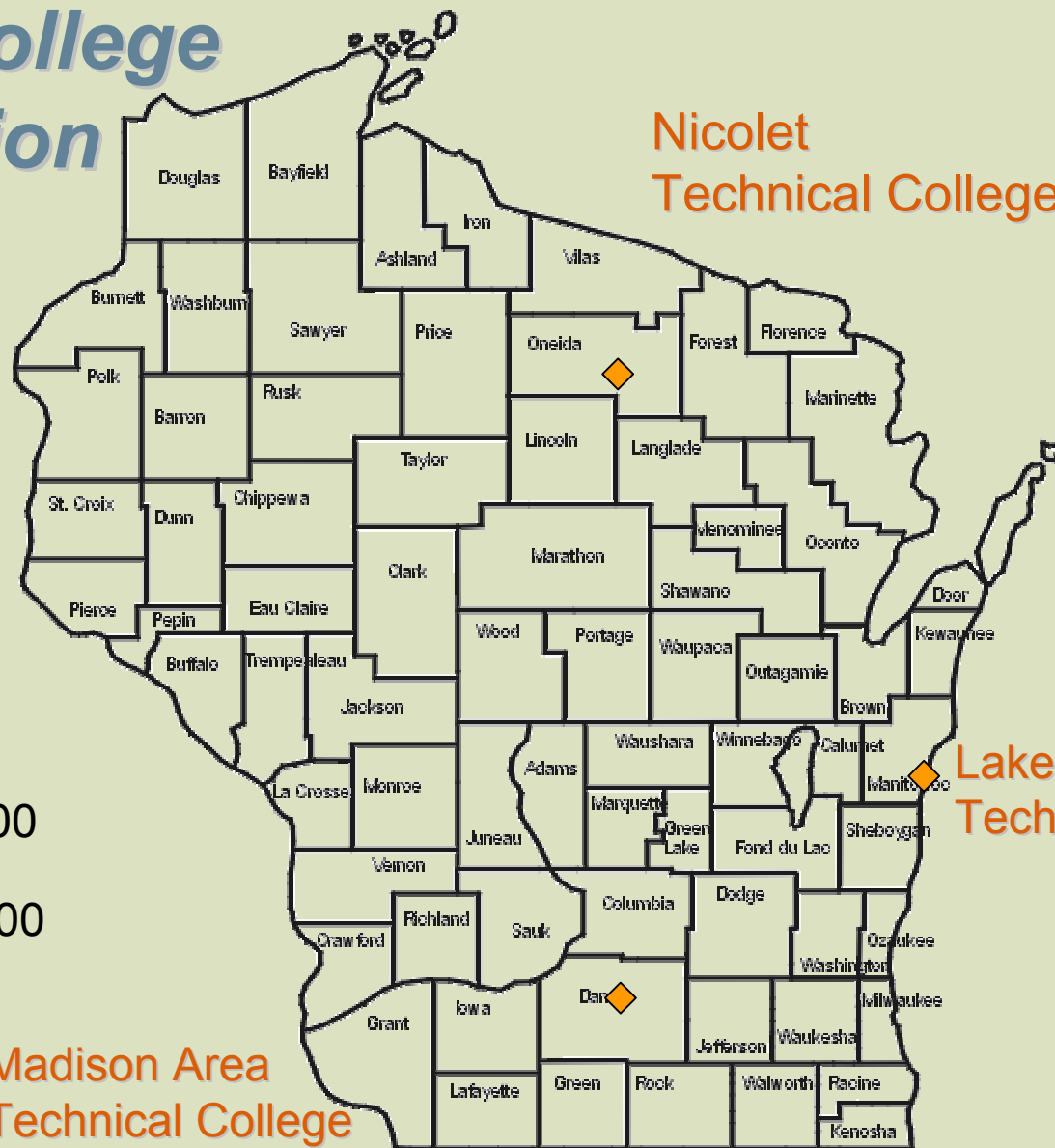
Project Costs: \$420,000

Dollar Match 1 to 1

Madison Area  
Technical College

Nicolet  
Technical College

Lakeshore  
Technical College



# Renewable Energy Technology R&D Grants – Round 1

## Five projects awarded: \$196,000 total

### **Marquette University**

**Municipal Anaerobic Digesters as Regional Energy Facilities**

### **Virent Energy Systems, LLC**

**Application of Aqueous-Phase Carbohydrate Reforming for Electricity Generation From Agricultural Products**

### **University of Wisconsin - Green Bay**

**Biogas Generation From A Wisconsin Dairy Farm Using Anaerobic Catalysis and/or Photocatalysis**

### **Bioenergy & Environmental, LLC**

**Application of Sonication Technology to Increase Biogas Generation**

### **Thermal Energy System Specialists**

**Development of a Zero-Net-Energy Building and Renewable Energy Technology Design Tool**

# **Renewable Energy Technology R&D Grants – Round 2**

**Six projects awarded: \$199,786 total**

**University of Wisconsin – Milwaukee: School of Architecture**

**Optimizing the Performance of Building Integrated Photovoltaic Systems**

**Superior Safety and Environmental Services, Inc.**

**Wind Resource Characterization of Lake Michigan Offshore Wind Resources –  
Correlation of Existing Data with Short-Term Wind Speed Sampling at Hub-Height**

**Cyclus Envirosystems, Inc.**

**Anaerobic Separation Technologies**

**Bioenergy & Environmental, LLC**

**Prototype High Solids/Phased Anaerobic Digester for Small to Medium Size Dairy  
Farms**

**Seventh Generation Energy Systems, Ltd.**

**Wind Resource Monitoring and Evaluation**

**Walter Novash**

**Development of a Web-Based Wind Site Assessment Tool for Wisconsin**



# **Future Renewable Program Directions:**

## **Commercial:**

- Zero-net-energy buildings incorporating multiple renewable energy technologies

## **Agricultural:**

- Community wind projects
- Agricultural waste added to manure in anaerobic digesters

## **Industrial:**

- Biomass fired stoker boilers
- Biomass co-firing with fossil fuel for boilers
- Biomass gasification
- Utilize existing and future waste heat streams to generate electricity
- Energy crops / bio-refineries / value added products

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